(12) UK Patent Application (19) GB (11) 2 343 996 (13) A

(43) Date of A Publication 24.05.2000

(21) Application No 9825315.6

(22) Date of Filing 20.11.1998

(71) Applicant(s)
NEC Technologies (UK) Ltd
(Incorporated in the United Kingdom)
Castle Farm Campus, Priorslee, TELFORD, Shropshire, TF2 9SA, United Kingdom

(72) Inventor(s)
Anthony Paul Banks

(74) Agent and/or Address for Service
NEC Technologies (UK) Ltd
Level 3, The Imperium, Imperial Way, READING, Berks, RG2 0TD, United Kingdom

(51) INT CL[7]
H05K 1/16 , H01C 7/00

(52) UK CL (Edition R)
H1S SAX SBA S5 S6A3 S7D S8A

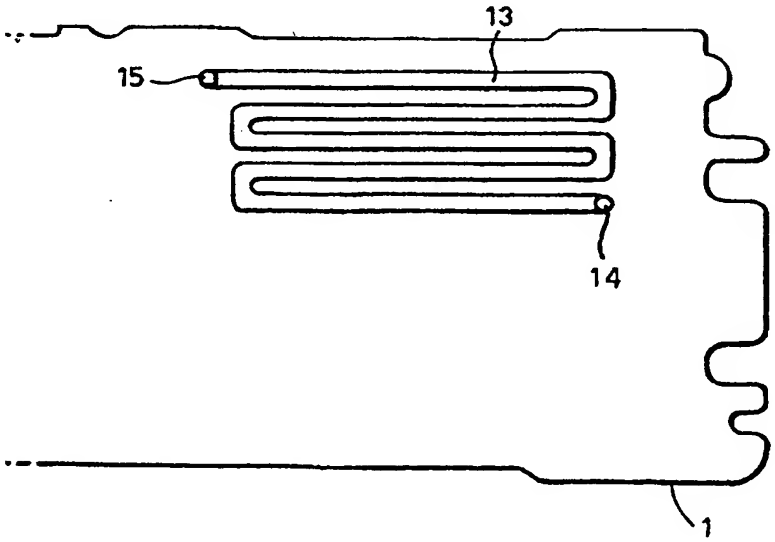
(56) Documents Cited
GB 2026250 A **EP 0837623 A1**
WPI Abstract Accession No.76-66005X/197635 & JP51081967 A

(58) Field of Search
UK CL (Edition Q) **H1S SAB SAX SBA SBB**
INT CL[6] **H01C 1/012 3/00 3/10 3/12 7/00 7/02 7/22 , H05K 1/16**
Online database: WPI, EPODOC, PAJ

(54) Abstract Title
A current sensing resistor

(57) A current sensing resistor 13 comprises a defined length, width and thickness of conventionally manufactured etched copper conductors on a printed circuit board 1. A number of such copper vias on one or more such circuit boards can be interconnected to provide a required value of resistance for the purpose of current sensing. Different values for the current sensing resistor are obtained by means of switching between different serial and parallel combinations of etched copper conductors. The problems of local heating normally associated with sensing resistors because of the power dissipated within the resistor are reduced by this arrangement. The current sensing resistor may be used as part of the charging circuit of a mobile phone or as input and output protection circuits for power supplies.

Fig.1.



GB 2 343 996 A

Fig.1.

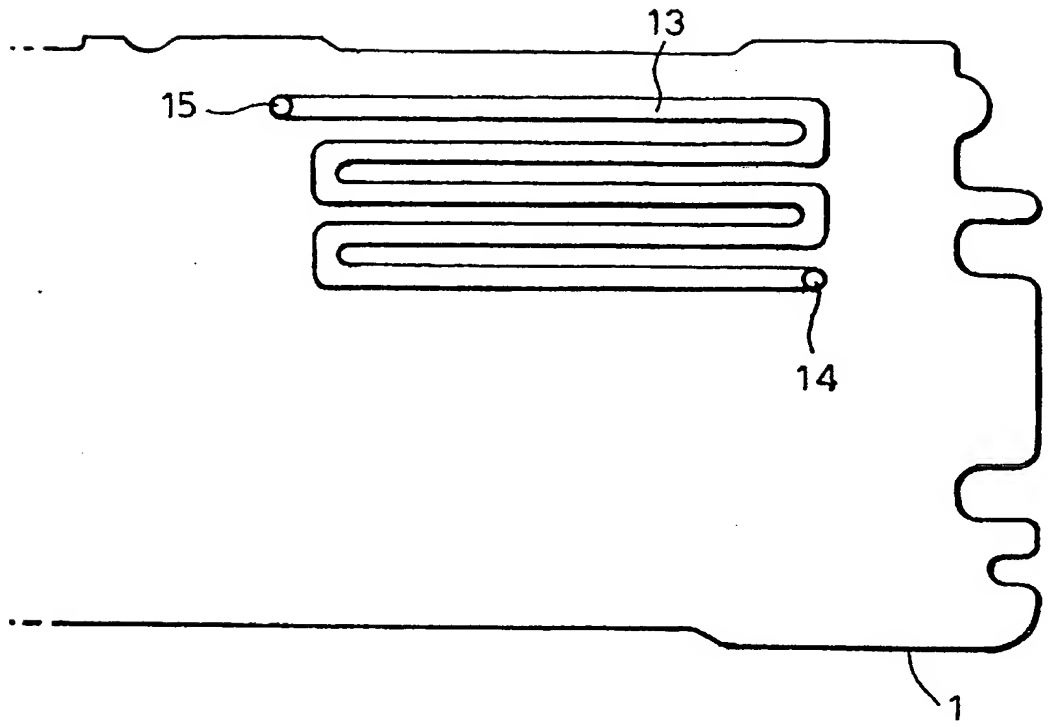
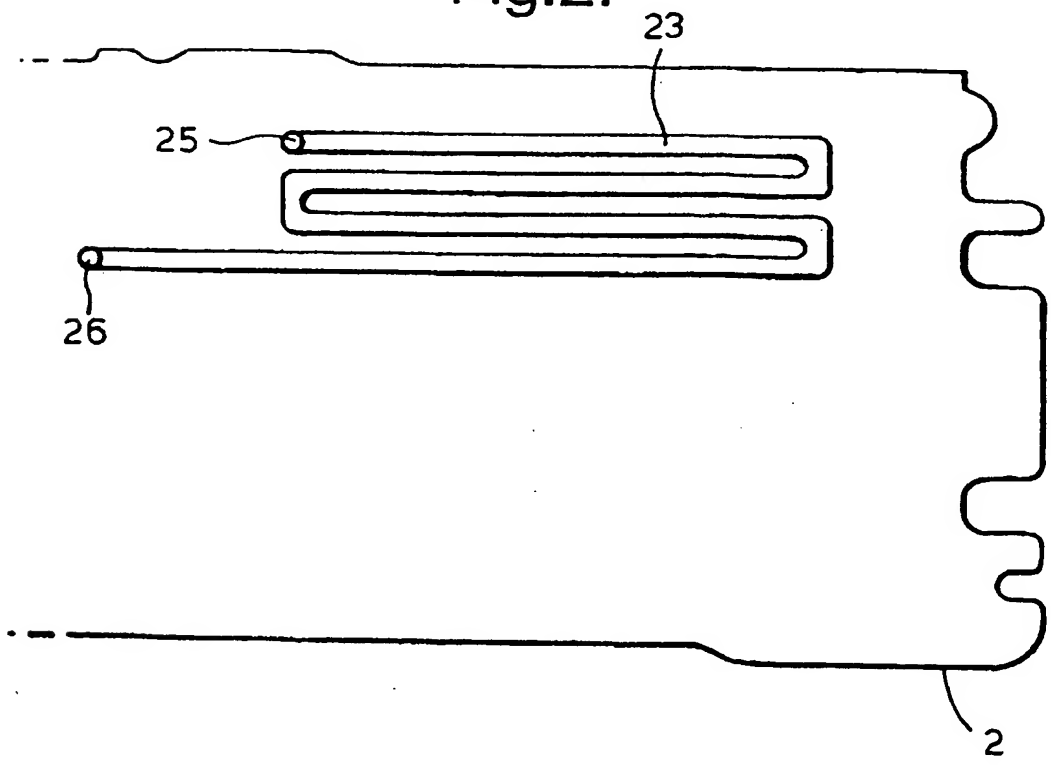


Fig.2.



Current sensing resistor

This invention relates to current sensing and has application particularly, though not exclusively, to mobile phones.

It is required, in certain circumstances, to sense (measure) the current flowing through a circuit. One such circumstance is for a mobile phone which may be connected to a number of different charging circuits. Charging of mobile telephones and the use of sensing resistors is discussed in e.g. WO 98/12791. Resistors formed from polymer thick film (PTF) conductive inks screened on to printed circuit boards (PCB's) are well known and are discussed in e.g. US 4870746 to Klaser.

An apparently simple and convenient method of sensing current is by means of a voltage measurement across an in-circuit resistance of known value. In practice, however, problems arise from use of the low value, high power dissipation resistors required. One larger resistor or a number of smaller resistors may be used. The design problems involved are local heating because of the power dissipated in the resistor(s), the volume taken up by the resistor(s) and the component costs. These design problems are particularly acute for mobile phones.

It is an object of the invention to provide a current sensing means with improvements over the prior art in terms of heat dissipation and component volume and cost.

According to the invention there is provided a current sensing resistor comprising a defined length, width and thickness of a conventionally manufactured etched copper conductor on a PCB.

An example of the invention will now be given with reference to the figures in which:

figure 1 shows in plan part of one layer of a multi-layer PCB,

figure 2 shows in plan part of a further layer of a multi-layer PCB.

With reference to figures 1 and 2, parts of two layers of a multi-layer PCB are illustrated with a first layer shown generally at 1 and a second layer shown generally at 2. The multi-layer PCB is part of a mobile phone and the batteries of the mobile phone must be re-charged from time to time. One or other of two different chargers may be used to re-charge the batteries. It is required to discriminate between the two different charging circuits on the basis of the current passing through a sensing resistor.

The two charging circuits are a fast charger supplying current at 850 milliamps and a slow charger supplying current at 200 milliamps. A sensing resistor of 0.3 ohms is used such that a voltage across the sensing resistor will be 255 millivolts for the high rate charger and 60 millivolts for the low rate charger.

The sensing resistor 3 has two parts shown as track 13 in figure 1 and track 23 in figure 2 and comprises a number of connected tracks or vias on both

layer **1** and layer **2**. These tracks are fabricated in the same way and preferably from the same material as in standard PCB production. The size and arrangement of sensing resistor **3** is dependent upon the value of the resistance required. In the sensing resistor **3** , as discussed above, a value of 0.3 ohms is required. Conveniently copper is used to form the resistor and the thickness of the tracks is essentially constant at $15 * 10^{-6}$ metres +/- $3 * 10^{-6}$ metres . The length of track required is thus about $365 * 10^{-3}$ metres. The input to sensing resistor **3** is at **14** and is connected via a socket to the external charger unit. A connection **15** connects track **13** on layer 1 through terminal **25** to track **23** on layer 2. Terminal **26** connects sensing resistor **3** to the battery via a standard control circuit.

Within the copper track, the resistivity can be assumed to be the same regardless of position or direction and therefore the following equation can be used to determine the width and/or length of copper track needed to provide the appropriate resistance.

$$\text{resistance} = \frac{\text{resistivity of copper} * \text{length of resistor}}{\text{width of track} * \text{thickness of track}}$$

The errors arising from temperature variation, manufacturing tolerances and other factors are relatively small and are insignificant in terms of the current measurements required in this example. Calibration and temperature compensation are therefore not required and some approximations in the length of track can be tolerated. Different shapes and configurations can be used but variations in track width due to curvature must be taken into consideration.

The location of the sensing resistor on each layer will depend on the spaces available on the multi-layer PCB and to some extent on the placing of components adjacent to the elements of the sensing resistor. Preferably components placed adjacent to the resistor elements will be such as to provide a heat sink. A battery module is one component able to provide a ready heat sink.

Considerable flexibility is available to the designer for the placement of parts of the sensing resistor on the PCB. The most convenient areas of the layers of the PCB not occupied by components can be used for the sensing resistor. A number of etched copper conductors may be interconnected in various serial or parallel combinations by means of switches to provide different values of resistance for the current sensing resistor.

A current sensing resistor as described may also be used as part of an output protection circuit of a power supply in order to determine if an excessive amount of current is being drawn from the supply, indicating a fault condition. Similarly a current sensing resistor as described may be used as part of an input protection circuit of a power supply in order to determine if an excessive amount of current is being drawn from the input to the power supply, indicating a fault condition.

Claims

1. A current sensing resistor comprising a defined length, width and thickness of conventionally manufactured etched copper conductors on a PCB.

2. A current sensing resistor as in claim 1 in which the thickness, within manufacturing tolerances, is constant over the length of the resistor.

3. A current sensing resistor as in claims 1 and 2 in which the width, within manufacturing tolerances, is constant over the length of the resistor.

4. A current sensing resistor as in claims 1 to 3 in which the resistor consists of etched copper conductors on more than one layer of a multi-layer PCB.

5. A current sensing resistor as in any preceding claim used within a mobile phone to determine the current flowing into said phone for the purpose of charging the battery within said phone.

6. A current sensing resistor as in claims 1 to 4 used as part of a protection circuit of a power supply in order to determine if an excessive amount of current is being drawn from the supply, indicating a fault condition.

7. A current sensing resistor as in claims 1 to 4 used as part of an input protection circuit of a power supply in order to determine if an excessive amount of current is being drawn from the input to the power supply, indicating a fault condition.

8. A current sensing resistor as in any preceding claim in which a number of etched copper conductors are interconnected in serial or parallel combinations by means of switches to provide different values of resistance for the current sensing resistor.

The Patent Office

INVESTOR IN PEOPLE

Application No: GB 9825315.6
Claims searched: All

Examiner: James Porter
Date of search: 15 February 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H1S (SAB, SAX, SBA, SBB)

Int Cl (Ed.6): H01C 1/012, 3/00, 3/10, 3/12, 7/00, 7/02, 7/22; H05K 1/16

Other: Online database: WPI, EPODOC, PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB2026250 A (PREH)	-
A	EP0837623 A1 (MACDERMID)	-
X	WPI Abstract Accession No. 76-66005X/197635 & JP51081967A (NITTO) 17.07.76 (See abstract)	1 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.